Northwest **Power** and **Conservation** Council

March 6, 2018

DECISION MEMORANDUM

TO: **Council members**

FROM: **John Ollis**
Power System Analyst

SUBJECT: **Decision to Release Marginal Carbon Emissions Rate Study**

PROPOSED ACTION: Release the final version of the Marginal Carbon Emissions Rate Study.

SIGNIFICANCE: The study of avoided carbon dioxide production rates of the northwest power system will evaluate what the implied avoided carbon emissions rate is in the WECC and the implications for regional conservation replacing the need for that production.

BUDGETARY/ECONOMIC IMPACTS

There are no effects on Council's budget. Council staff performed analysis supporting this study.

BACKGROUND

The cost of future carbon dioxide regulation has been a significant factor in resource planning in the Pacific Northwest. To avoid making higher cost resource choices, a direct evaluation of this risk requires an estimate of the carbon dioxide emissions avoided by purchasing conservation or another resource. The Council has periodically produced this study using the AURORA model to help inform Council staff and regional stakeholder analysis.

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Per the discussion in the January and February 2017 Power Committee, and April Council Meeting, AURORA has been used as the Council's wholesale market electricity price forecasting model. The first draft of the study was released for public comment in April 2017. In response to that public comment, staff developed, in conjunction with the System Analysis Advisory Committee, a slightly different methodology for calculating the best estimate for an avoided carbon dioxide emissions rate. This updated draft reflects the new methodology and results. This second draft was released in the January 2018 Council Meeting for stakeholder comment. The updated final draft of the paper contains edits and observations from that stakeholder feedback.

ANALYSIS

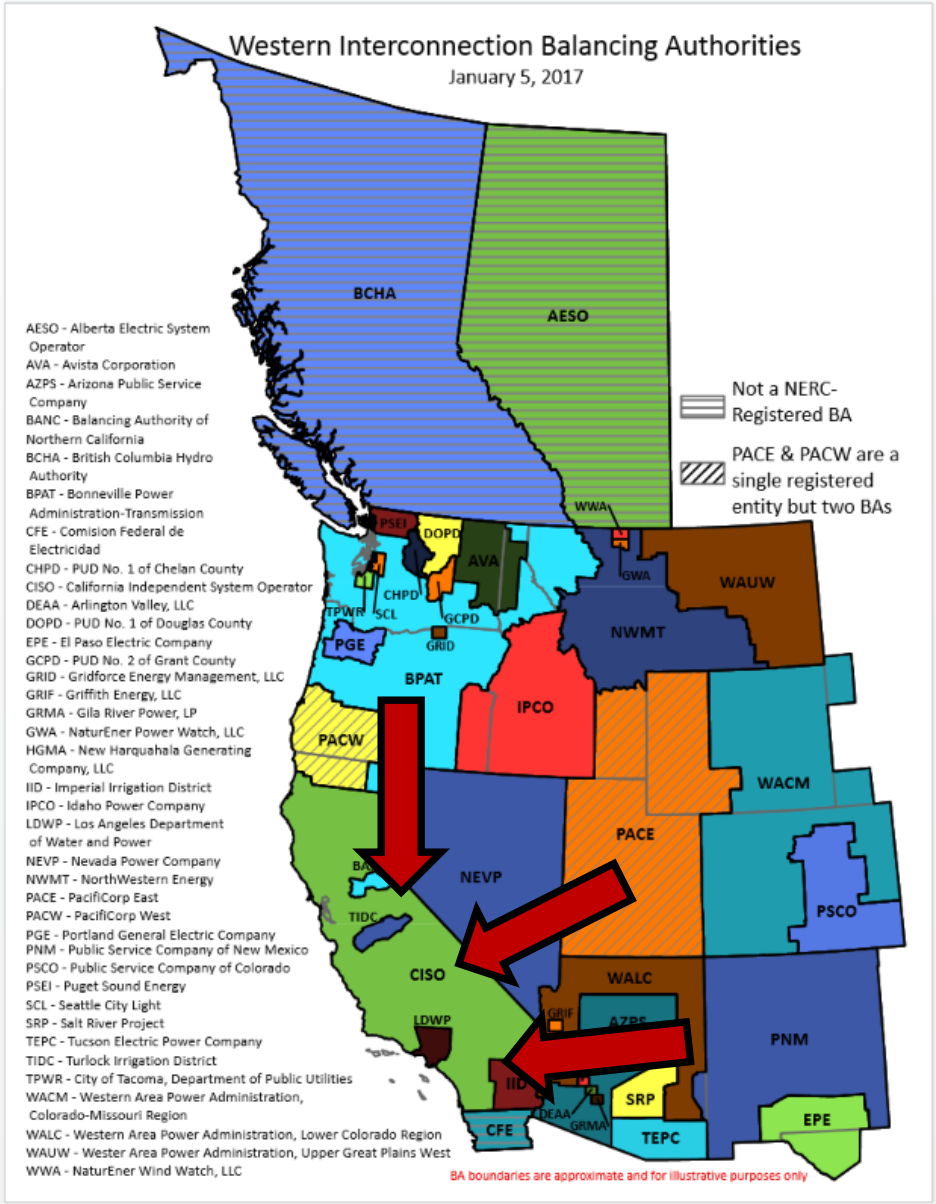
The results of this study show an annual range for the marginal emissions rate of 0.91 pounds of CO_2 per kilowatt-hour to 1.83 pounds of CO_2 per kilowatt-hour for the existing policy scenario.

ALTERNATIVES

The Council could postpone the release of the paper, expand the scope and ask for more stakeholder feedback. Current feedback from most stakeholders seems to indicate further interest exists in expanding the scope of the study, but that the current study is sufficient.

ATTACHMENTS

The Council's paper, "Avoided Carbon Dioxide Production Rates in the Northwest Power System" was sent separately to Council Members.



Marginal Carbon Dioxide Production Rate Report: Study Release

Power Committee
John Ollis
March 13th, 2018

Why are we Having this Discussion Again?

1. Stakeholder response to first draft asked for more involvement and input on methodology.
2. Multiple meetings with SAAC on methodology.
3. Similar average results, but larger ranges and different reasoning.
4. Approval to release second draft of study.
5. Second draft of study released in January 2018 for stakeholder feedback.
6. Report on stakeholder feedback and release final study in March 2018.

Context for Results

- Recall:

1. Contemporary natural gas-fired combined cycle unit emits roughly 0.8 to 0.9 pounds (lbs.) of CO2 per kilowatt-hour.
2. A typical conventional coal-fired steam unit emits roughly 2.1 to 2.4 lbs. of CO2 per kilowatt-hour.
3. Peaker gas units have a larger range of emissions rates 1.1 to 1.7 lbs. of CO2 per kilowatt-hour.

Annual Avoided Emissions Rate (lbs. of CO_2 per kWh) by Scenario

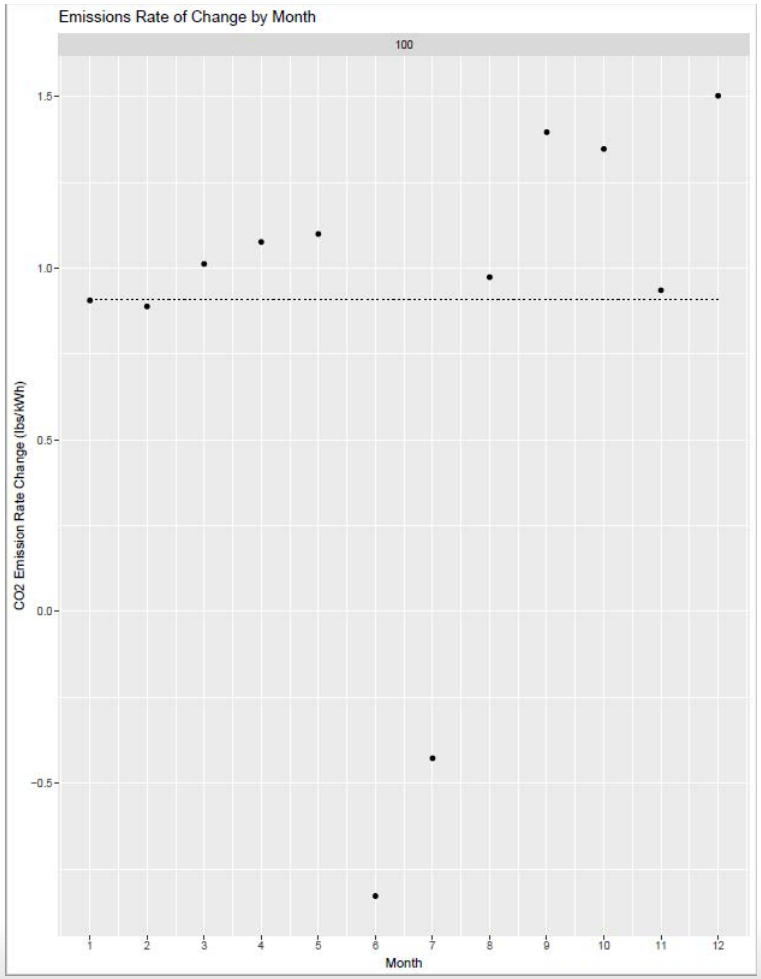
Scenario	Existing Policy	Social Cost of Carbon
2016	1.83	1.40
2021	0.91	0.58
2026	0.93	0.70
2031	0.97	0.55

- *Modern natural gas-fired combined cycle unit emits 0.8 to 0.9 lbs. of CO2 per kWh.*
- *Conventional coal-fired steam unit emits roughly 2.1 to 2.4 lbs. of CO2 per kWh.*
- *Peaker gas units have a larger range of emissions rates 1.1 to 1.7 lbs. of CO2 per kWh.*

Stakeholder Discussion

- The last draft was open for comment until February 16, 2018.
- Comments and observations were incorporated into final draft and sent to SAAC participants fora final check.
- Main comments/questions
  1. Appropriate usage
     a. Depth of net load reduction
     b. Shape of net load reduction
  2. Methodology

WECC Avoided Carbon Emissions Rate Methodology



The *average avoided emissions rate* over the output changed in the WECC from the flat drop of 100 MW in 2021 is

$$\frac{Emissions_{100} - Emissions_0}{Output_{100} - Output_0} = .91 \text{ lbs/kWh}$$

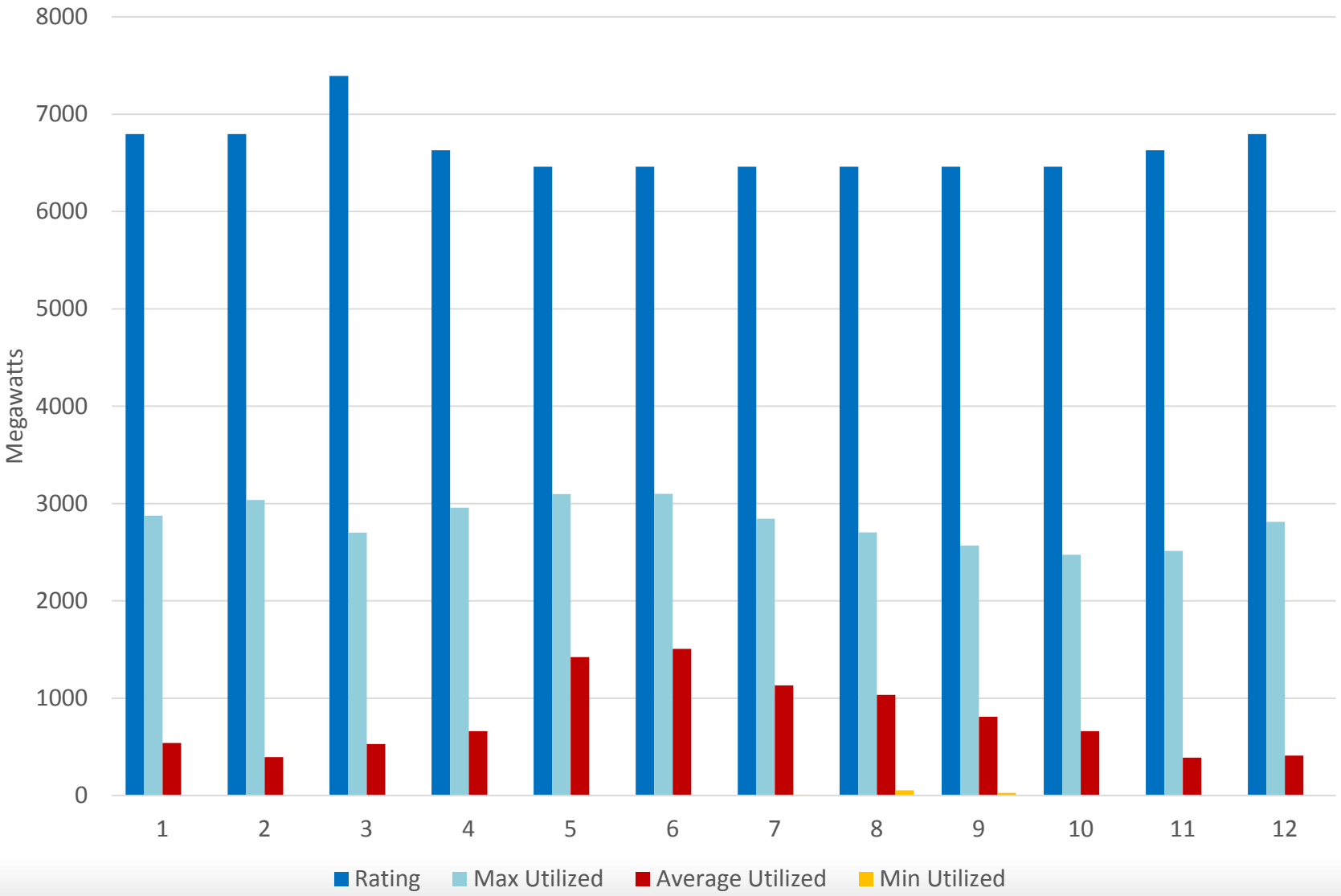
Variable Definition:

1. $Emissions_{100}$ is the emissions in the WECC with 100 MW less load run
2. $Emissions_0$ is the emissions in the WECC in the base run
3. $Output_{100}$ is the output in the WECC with 100 MW less load run
4. $Output_0$ is the emissions in the WECC in the base run

Main Drivers of Emissions Rate Changes

- NW export levels (hydro variability)
  - If CA does not get power from us, they get it from coal and gas plants in Desert Southwest or Mountain West.
- Amount of coal in middle WECC resource stack.
  - Most not in NW
  - Over 11,000 MW of scheduled coal retirements in WECC between 2016 and 2031

Regional Exports to California



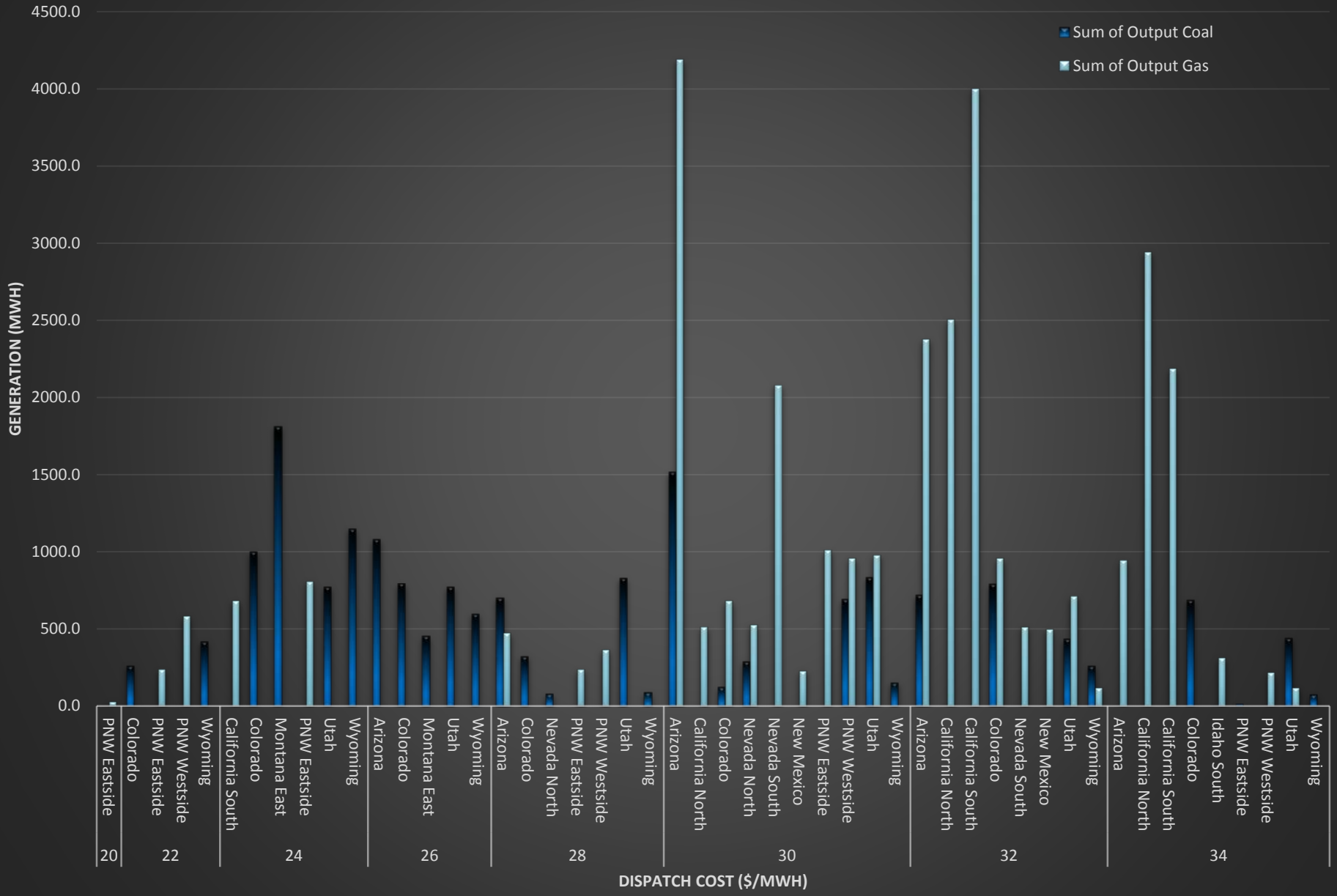
Tra
To
AU


Seattle
WASHINGTON
MONTANA
Missouri
Portland
OREGON
IDAHO
WYOMING
CALIFORNIA
Salt Lake City
Denver
GREAT BASIN
UTAH
NEVADA
COLORADO
Sacramento
San Francisco
Mt Whitney
Fresno
Las Vegas
Colorado
COLORADO PLATEAUS
Los Angeles
ARIZONA
NEW MEXICO
Phoenix
San Diego
Tijuana
Tucson
El Paso

What are we optimizing?

- The optimization in AURORA is focusing on meeting load at the **lowest cost**.
- Optimizing for the **lowest CO2 emissions** would be a different objective.
- Varied fuel types lead to big emissions rate swings from
  - Hour to hour, and
  - Hydro condition to hydro condition, but
  - On an expected basis similar to rate of CCCT

Simulation of WECC Dispatch July 9th, 2021 at 7 PM 2001 Hydro Conditions



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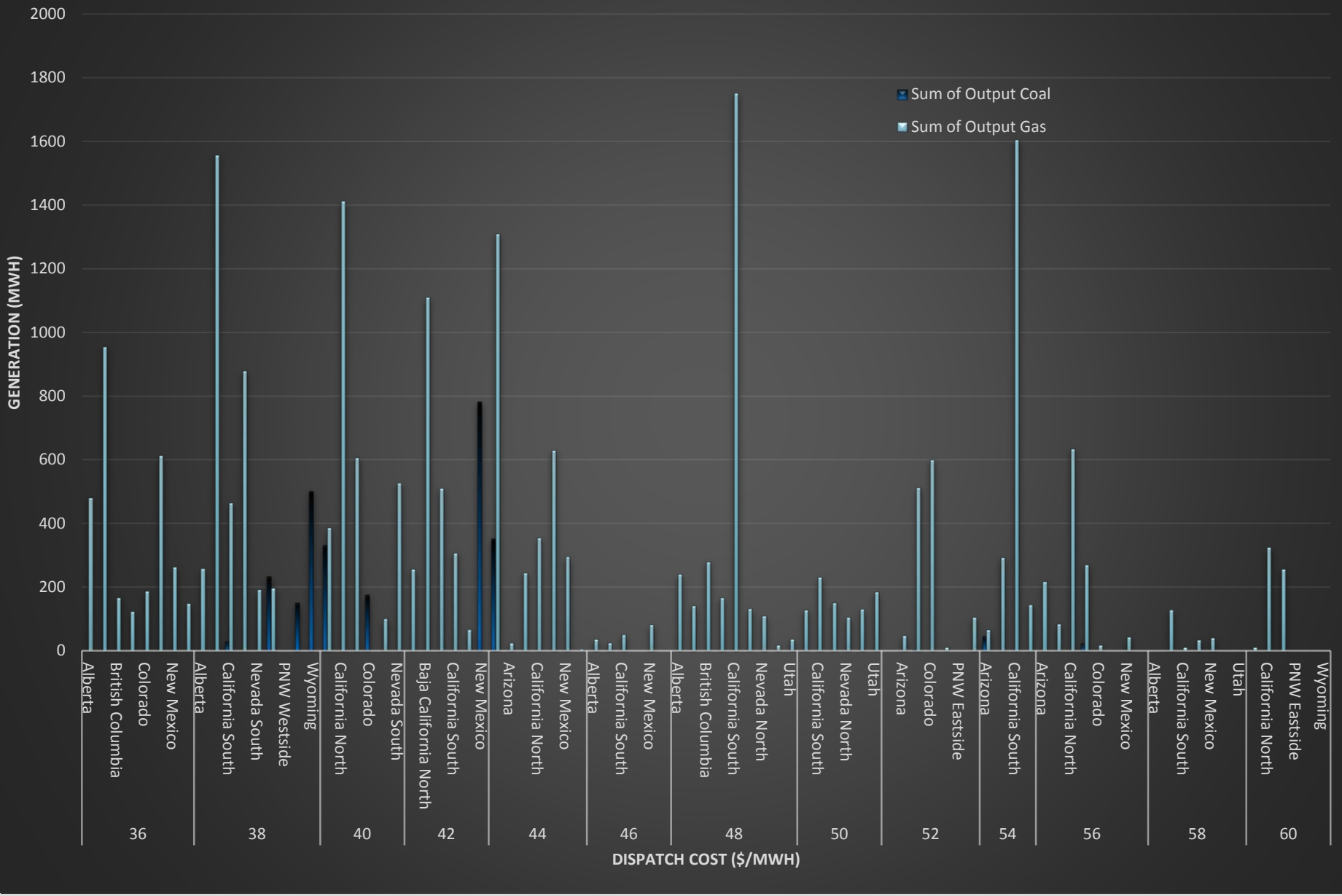
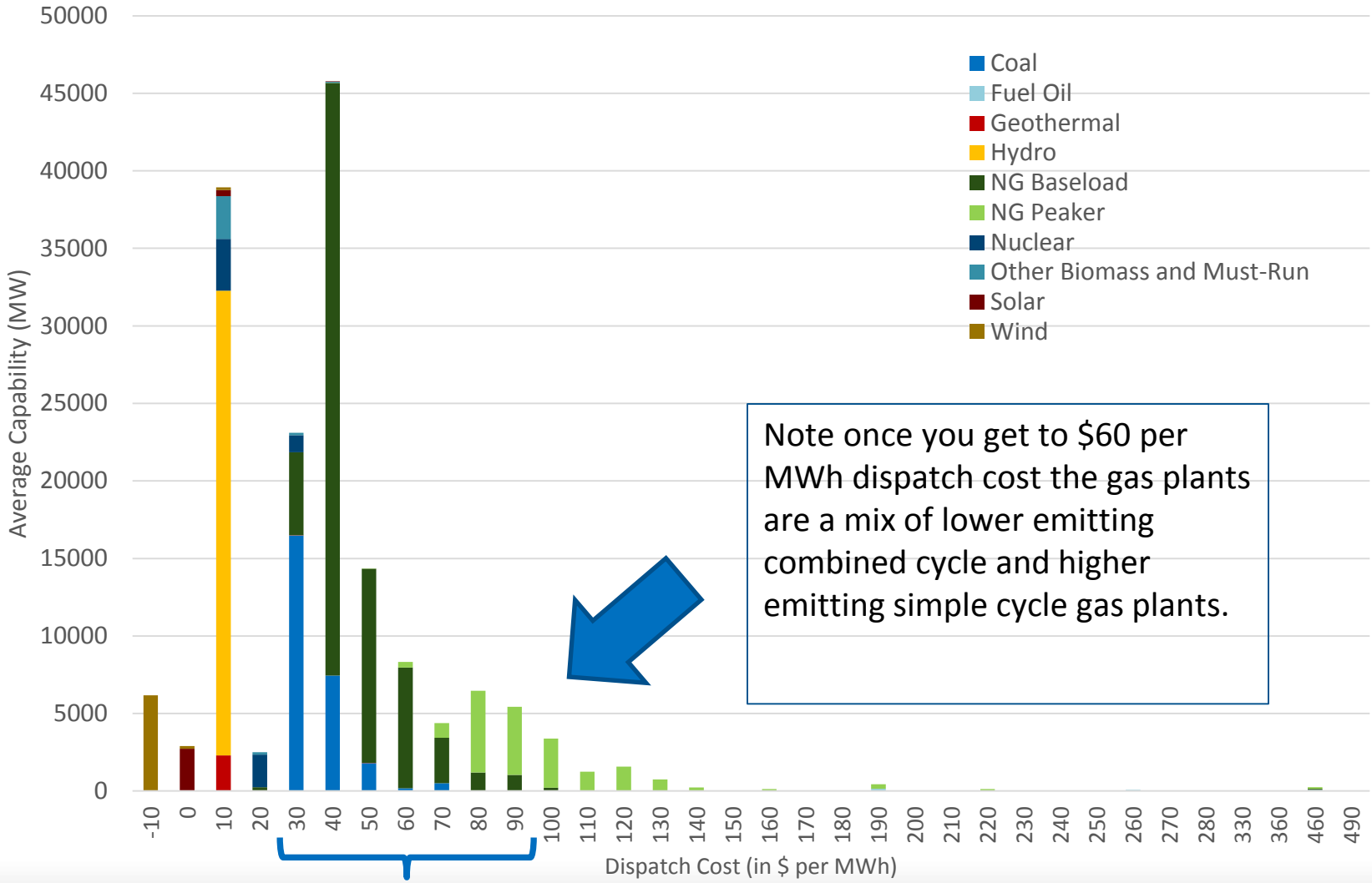


2021 WECC Resource Portfolio - Good Hydro Conditions



Annual Avoided Emissions Rate (lbs. of CO_2 per kWh)

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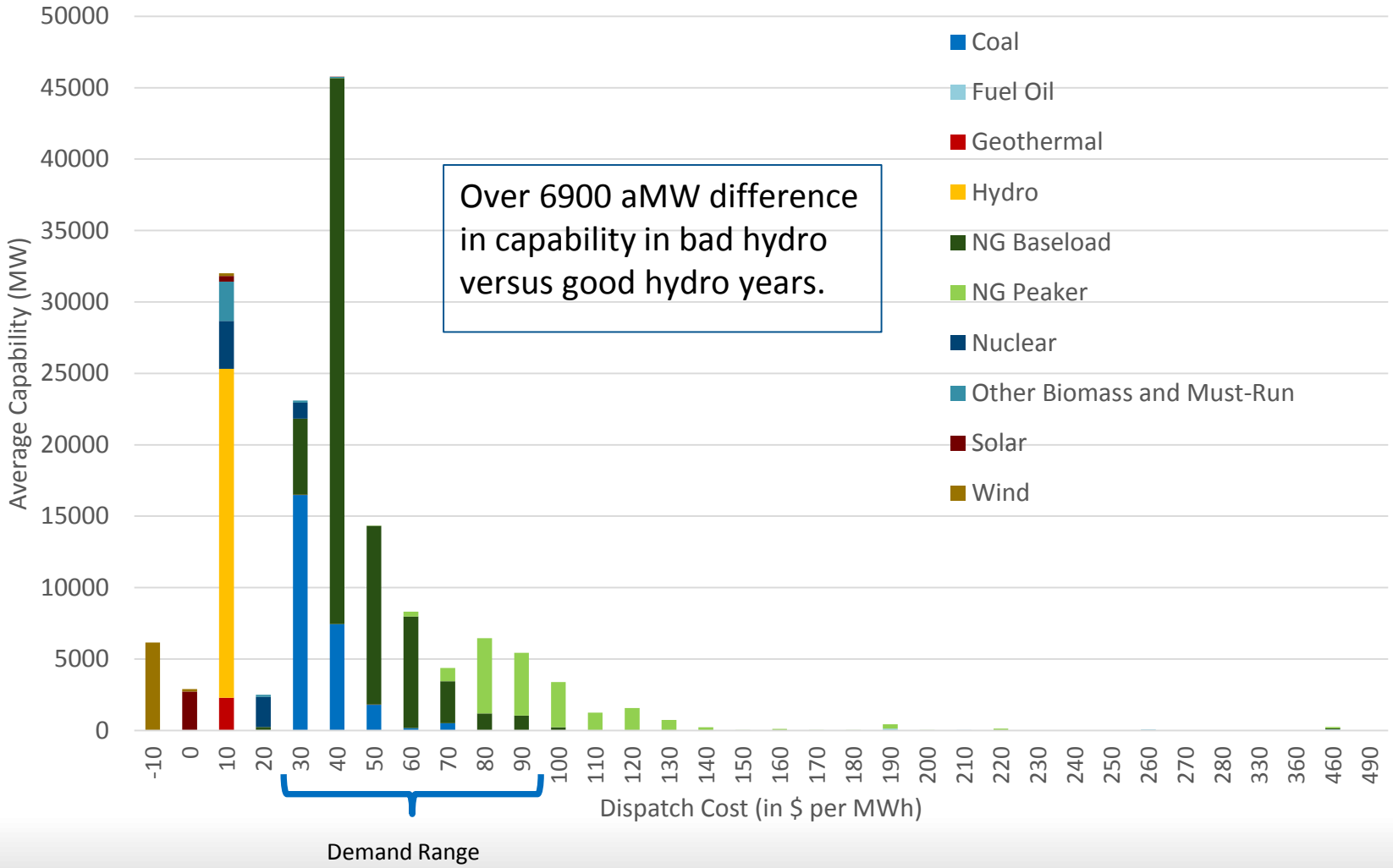
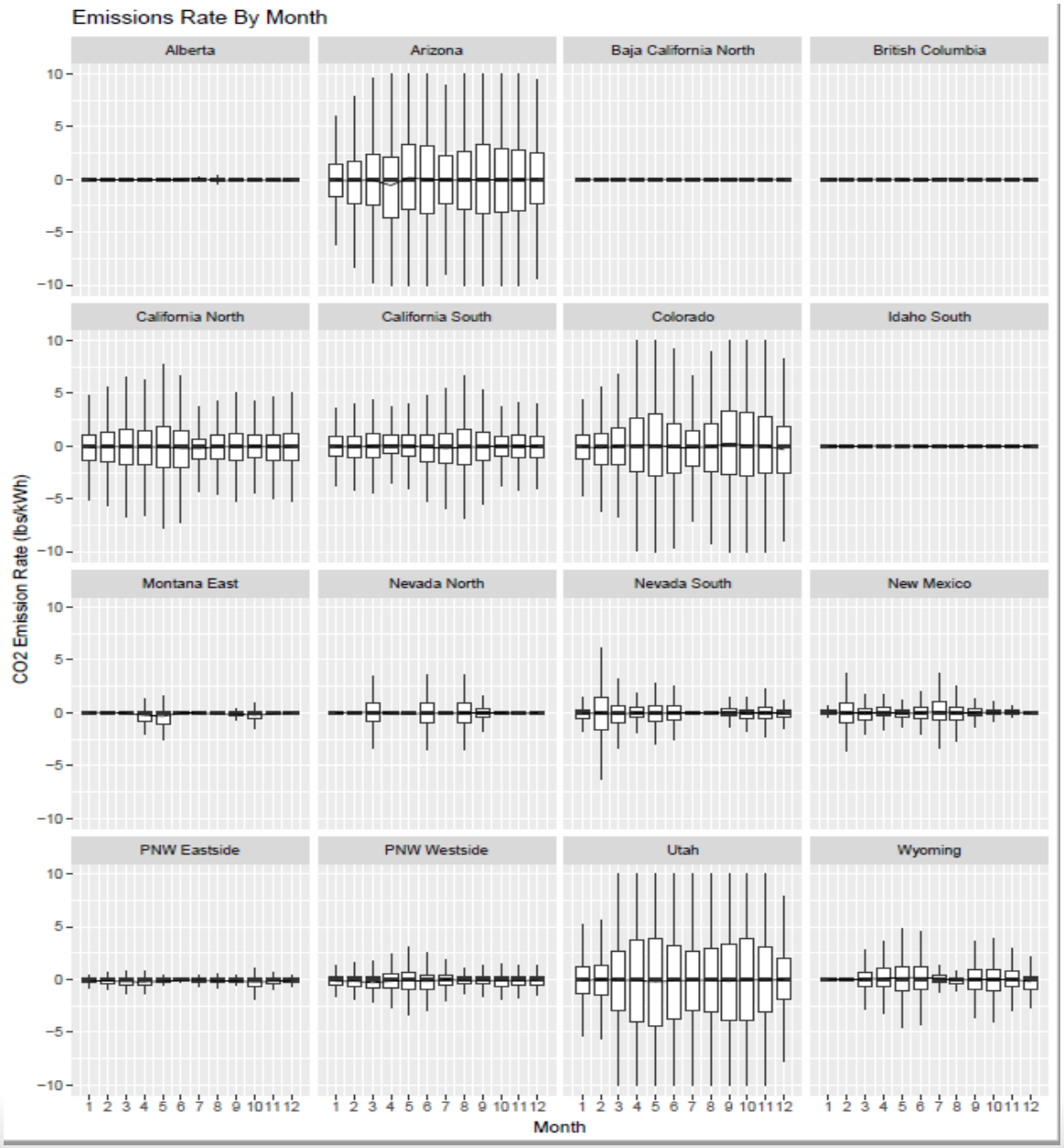
Approval to Release Study

- Questions?

Additional Content for Reference

2021 WECC Resource Portfolio - Poor Hydro Conditions





WECC Emissions Rate Changes by Zone

Notice the spreads are large but the net effect may still be small depending on how much output is increased or decreased at that emissions rate

WECC-wide data

- Change in fuel usage at plants
  - What types of plants are driving the emissions rate?
- Change in delta emissions and output
  - Where are plants changing output?
  - What is driving the large emissions changes?
  - Is this driven by hydro exports?

Box Plot Review

Since we need to look at distributions of results...

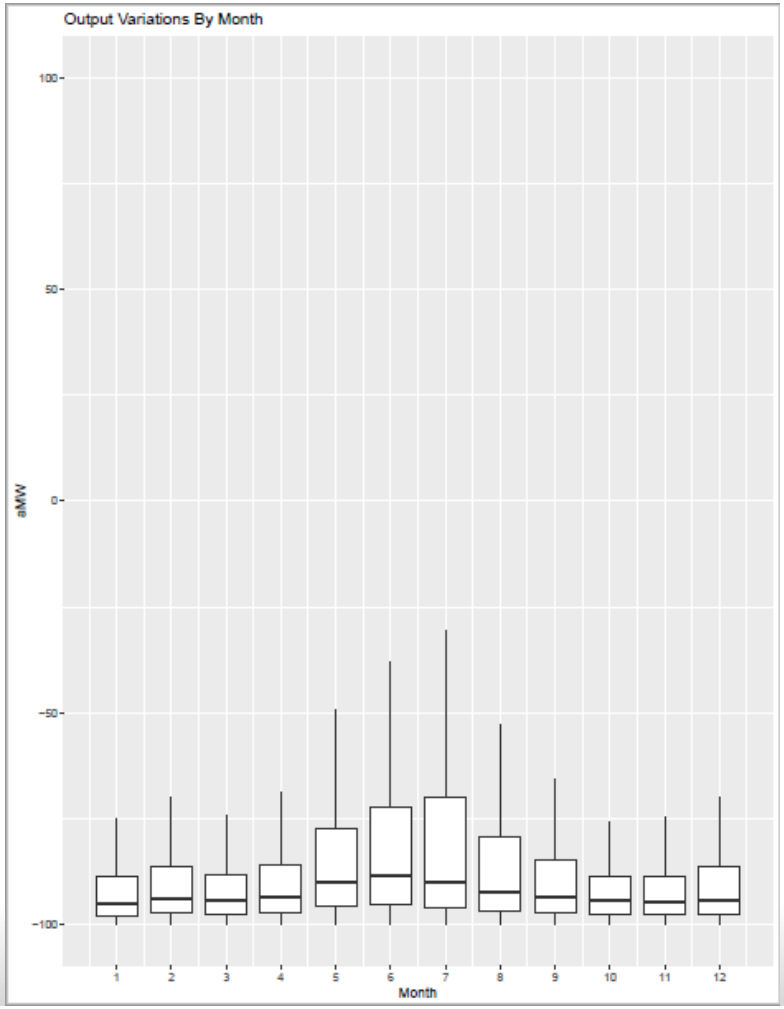
- Lower boundary on box: 25% quantile
- Middle line: 50% quantile
- Upper boundary on box: 75% quantile
- Min and max whiskers:

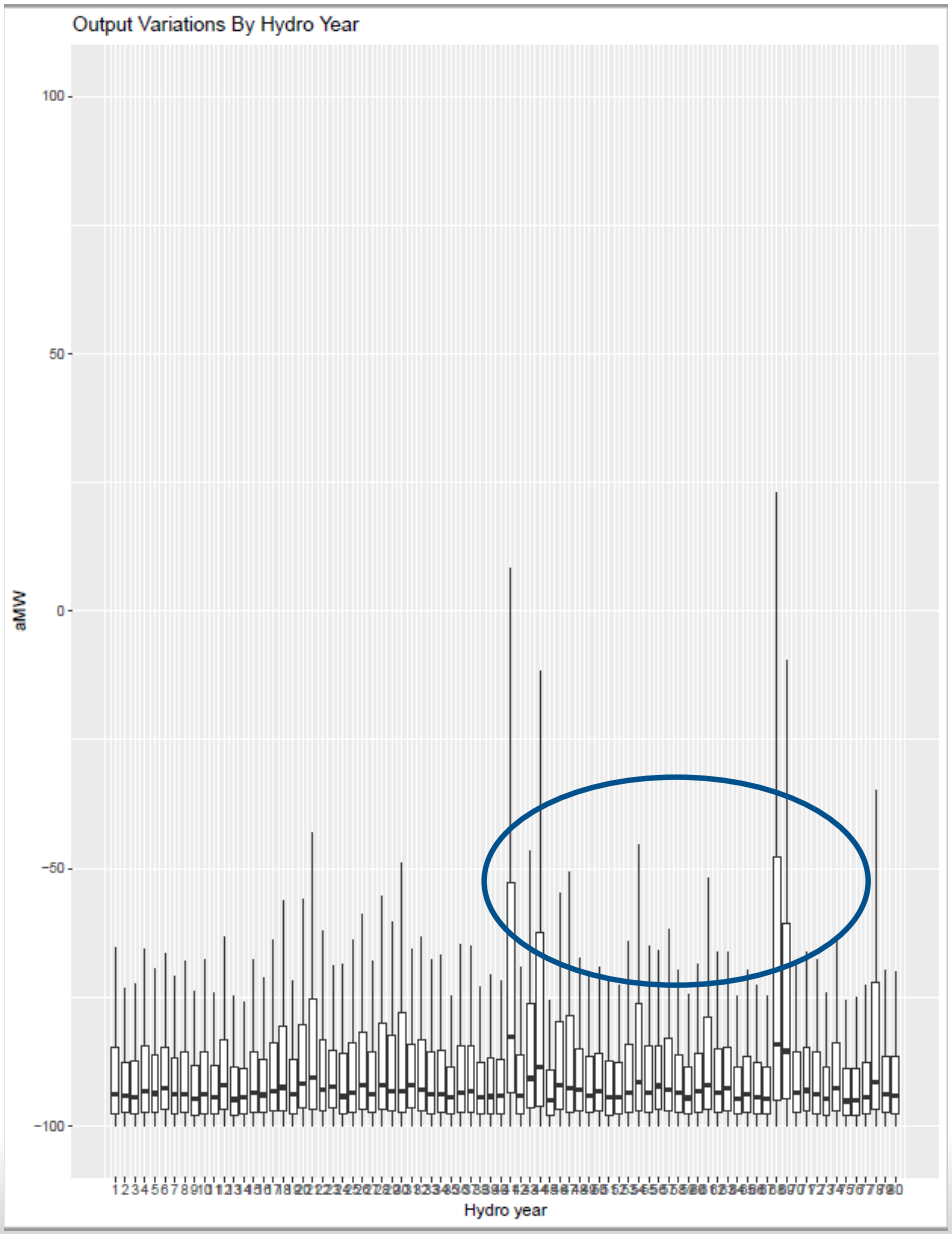
(Min Observation-1.5*IQR, Max Observation+1.5*IQR)

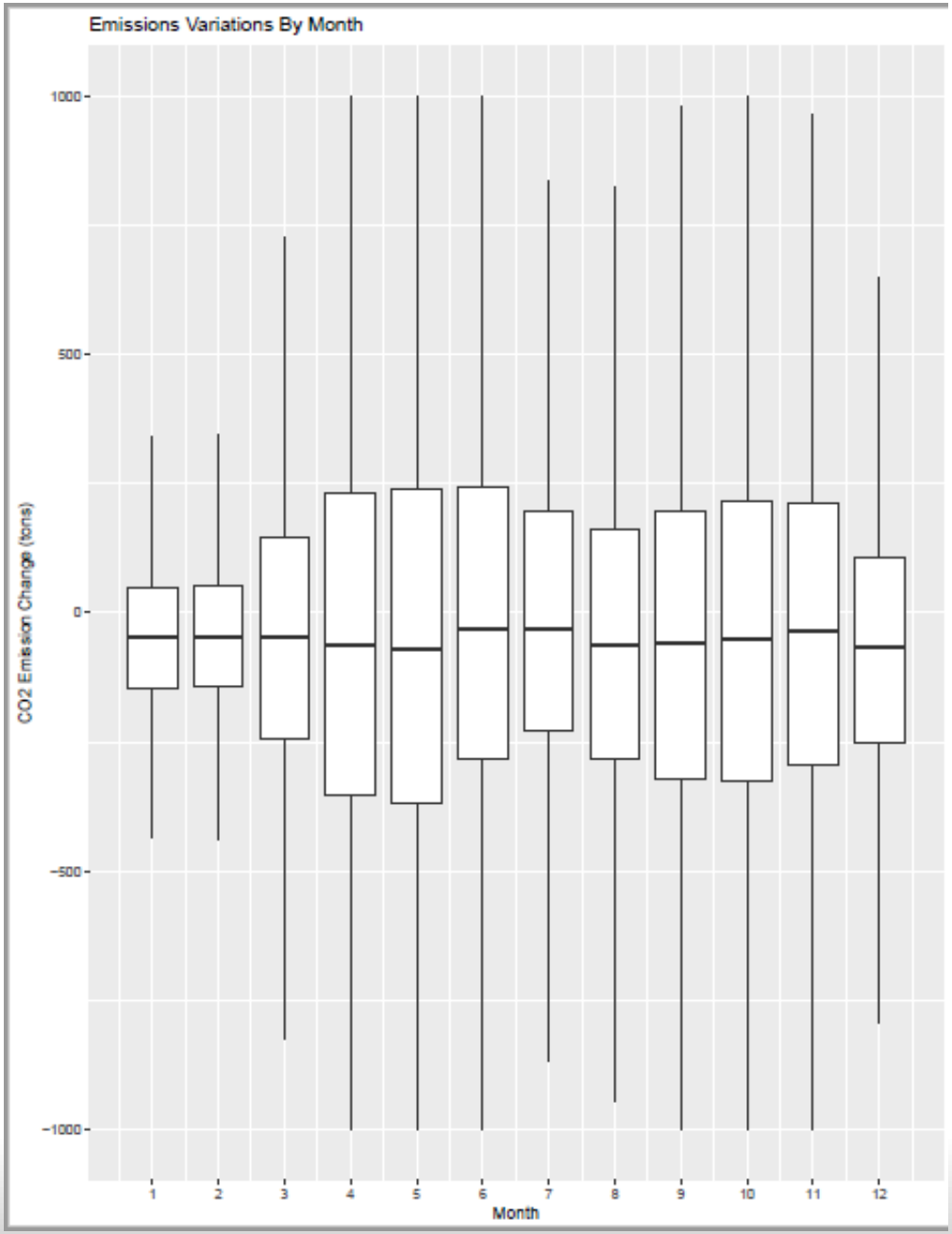
  - IQR is Interquartile range

WECC Output Change

As expected, this is close to 100 MW less output in the WECC corresponding to the flat load drop of 100 MW in the PNW Westside.





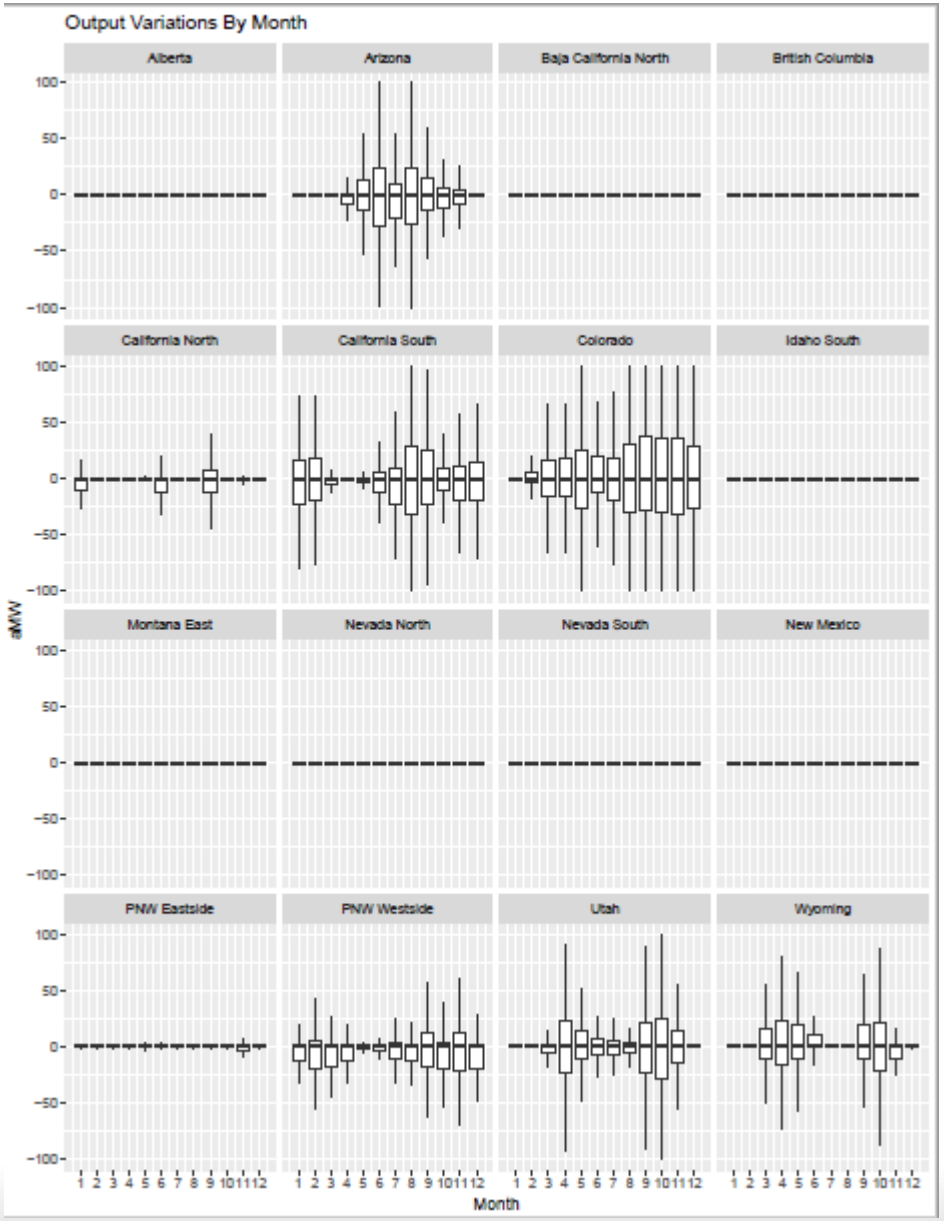


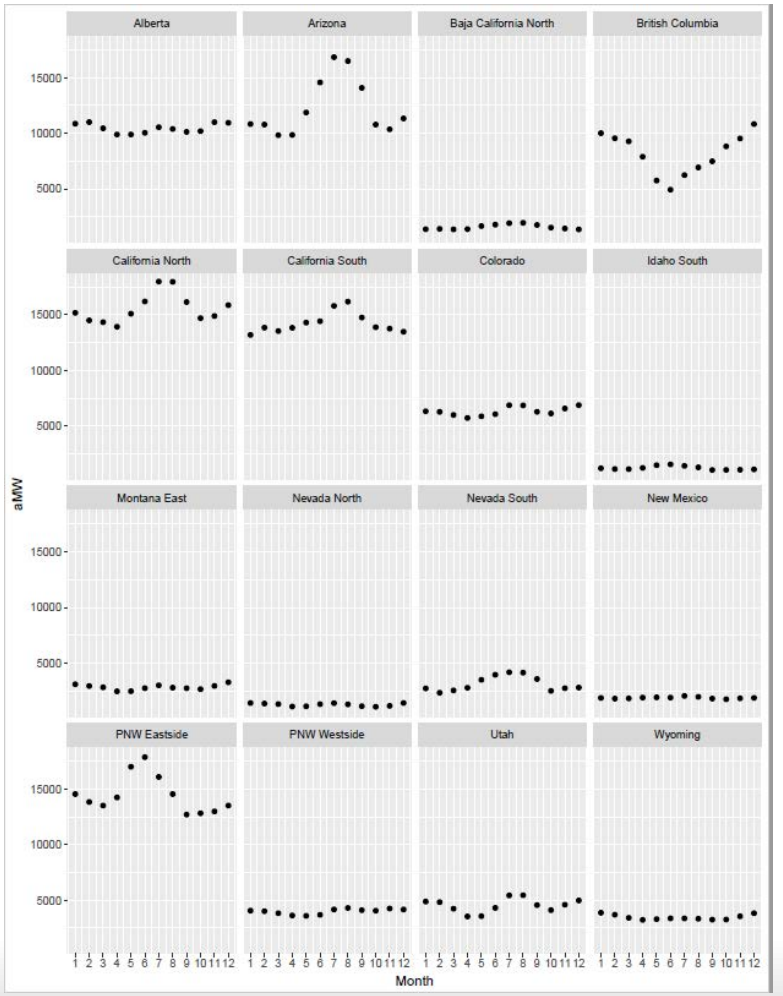
WECC Emissions Change

For context, all the changes in emissions are very small (<<1%) in comparison to the total amount of WECC Emissions in a month.

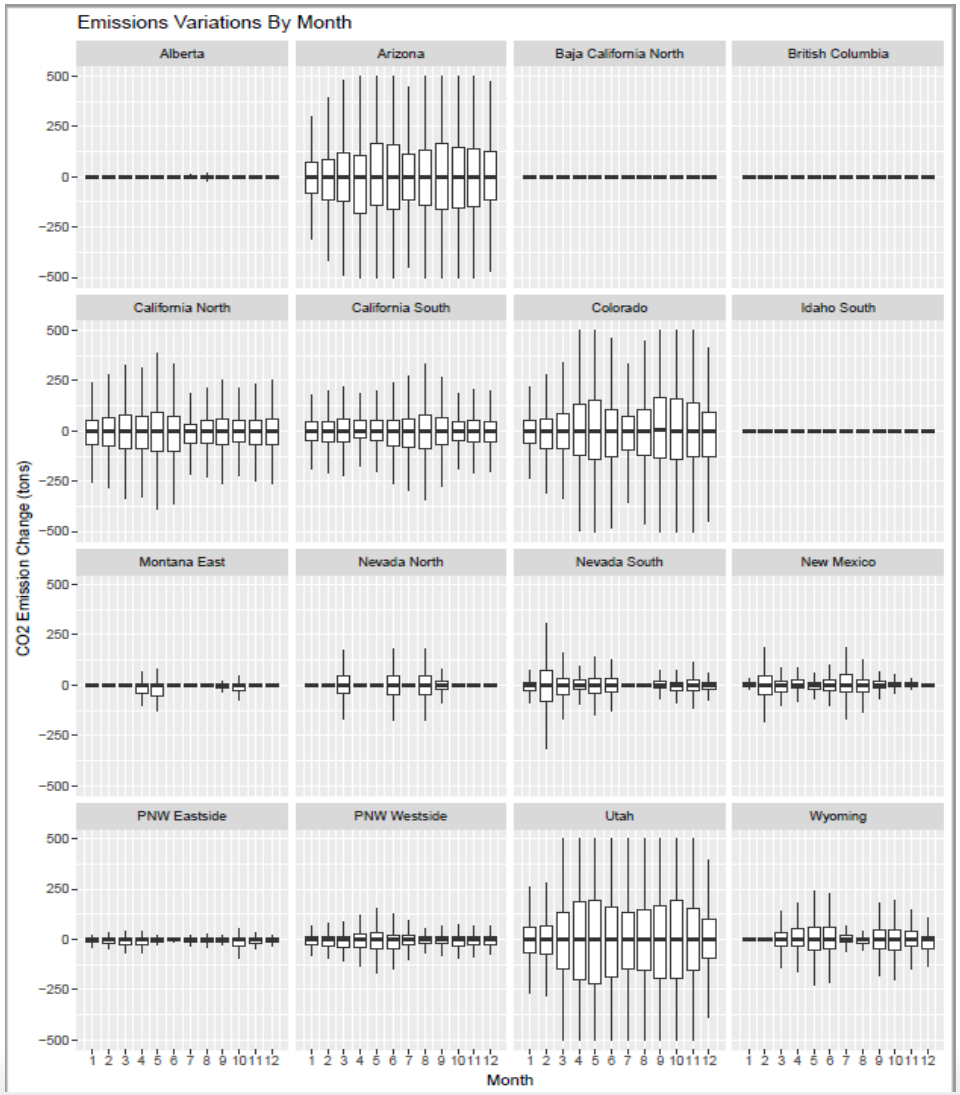
	Report_Month	Amount
1	1	61319815
2	2	54787489
3	3	55211064
4	4	47719302
5	5	52770715
6	6	56887022
7	7	67330810
8	8	67567049
9	9	58443896
10	10	54794026
11	11	56928405
12	12	62391053

WECC Output by Zone

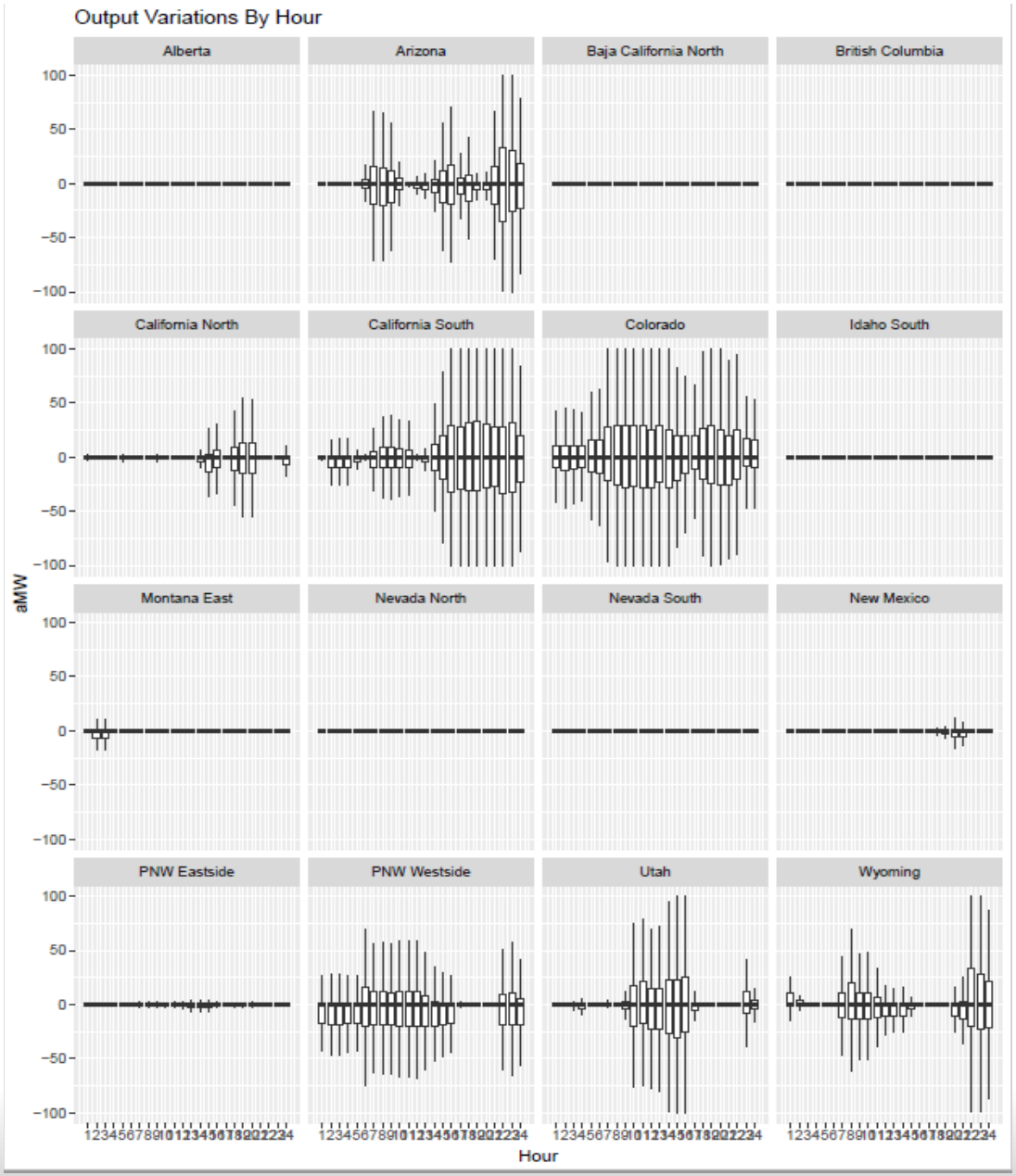




WECC Emissions Change by Zone

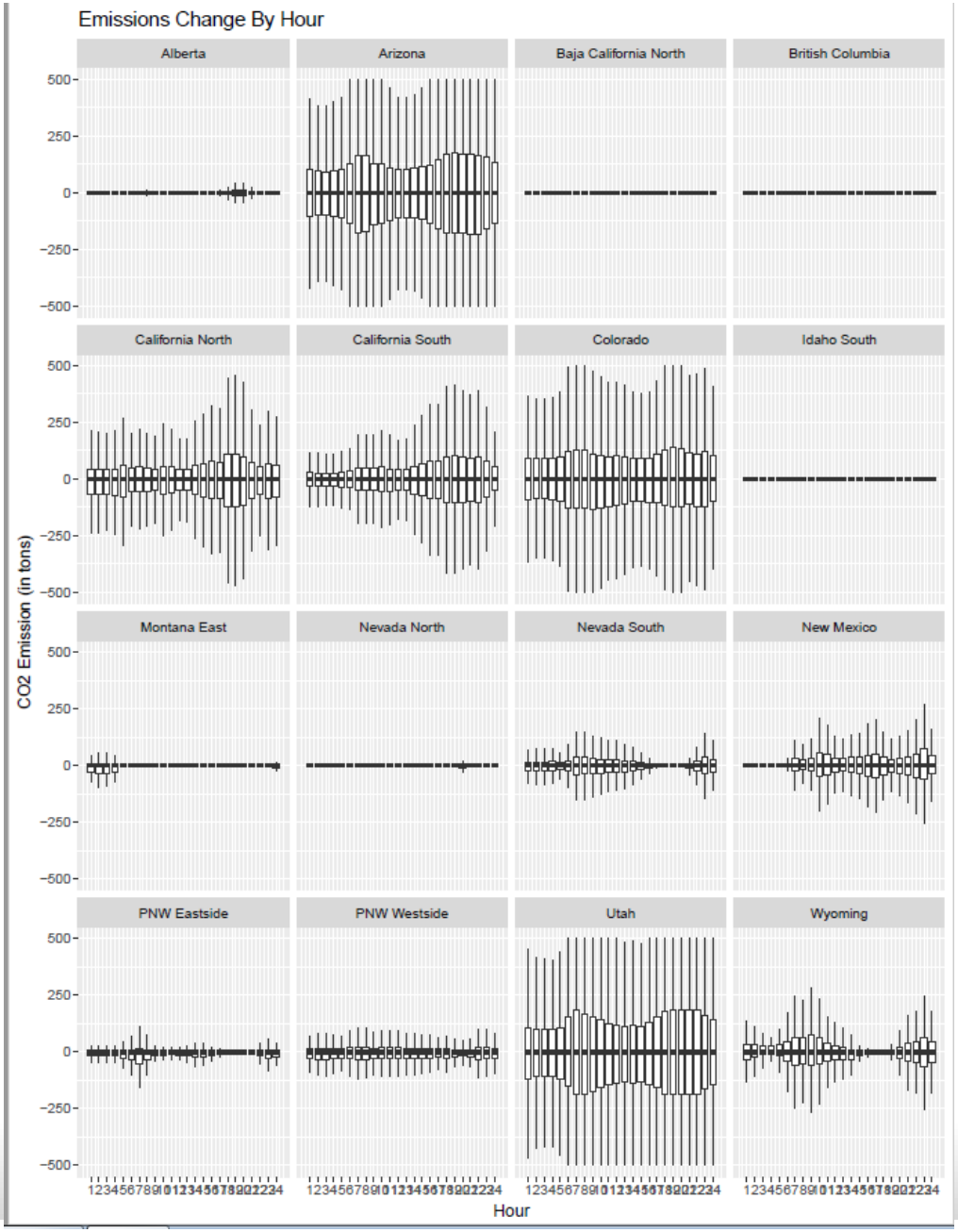


Notice that most of the emissions change happens in a few zones and not much in the NW



Output Change By Hour

There are some patterns here, like more variation around the daily load shape in certain zones.



Emissions Change By Hour

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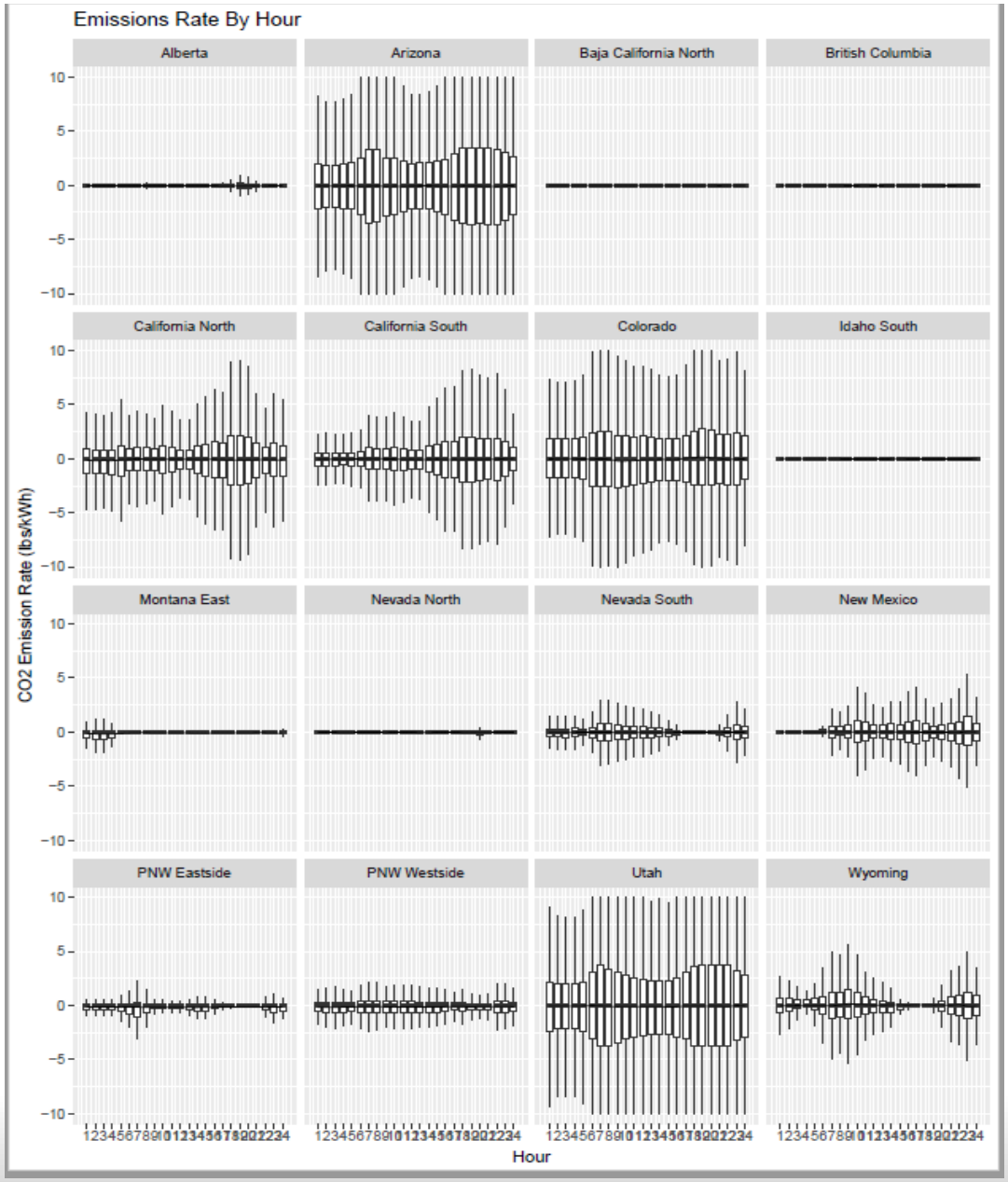


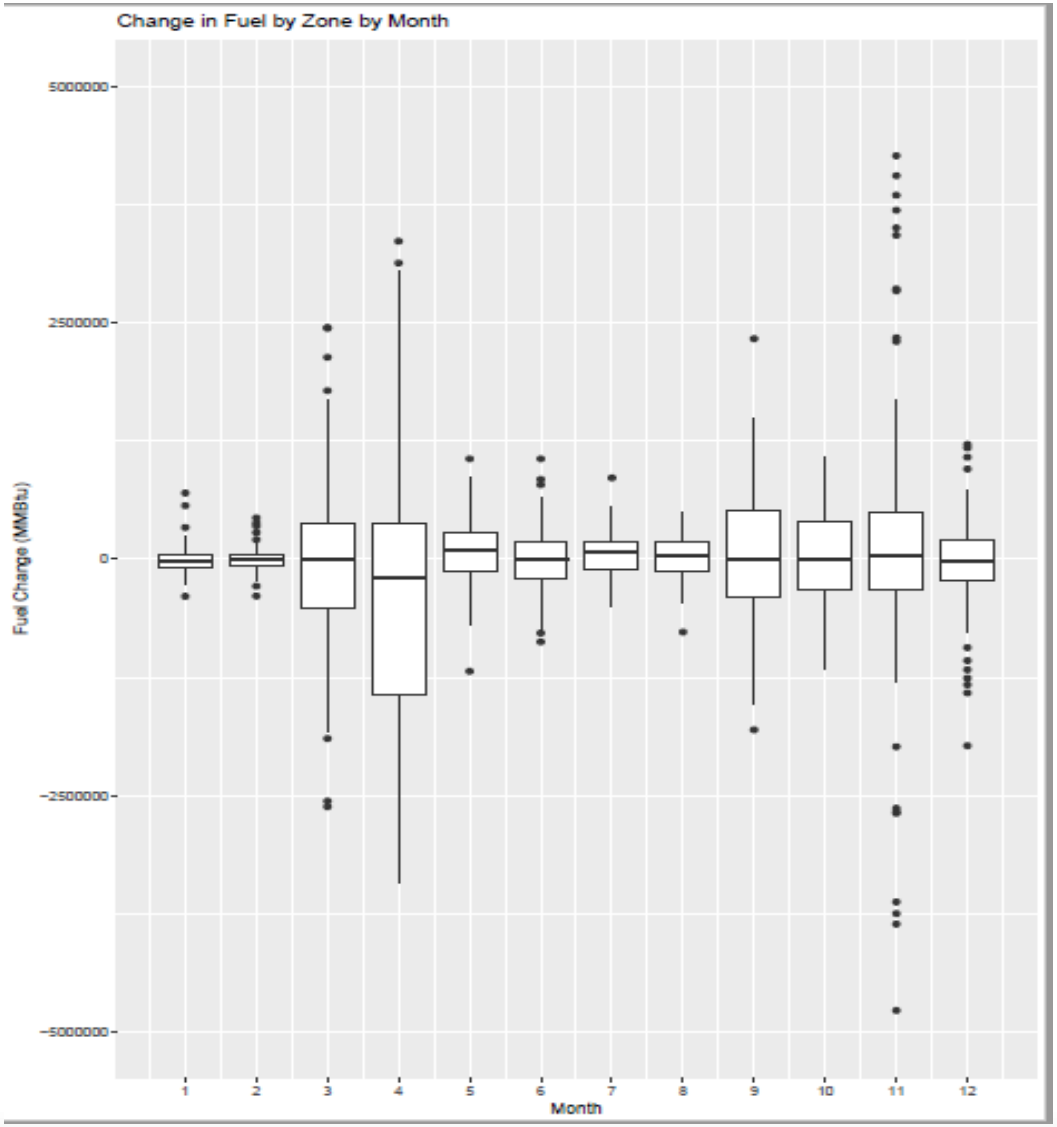
Emissions Rate Change By Hour

There are some similar patterns here, like more variation around the daily load shape in certain zones.

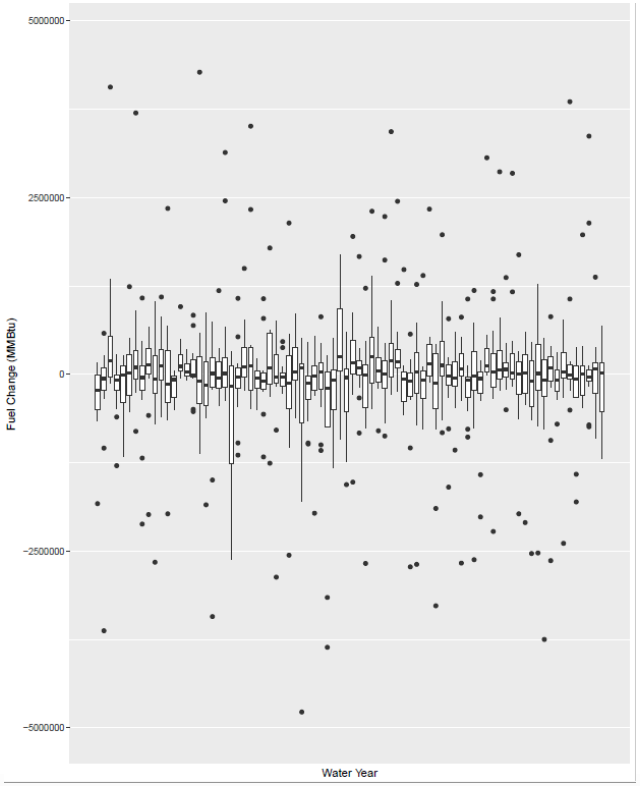
Coal plant fuel usage in Arizona changes the more than any fuel by month, but why?

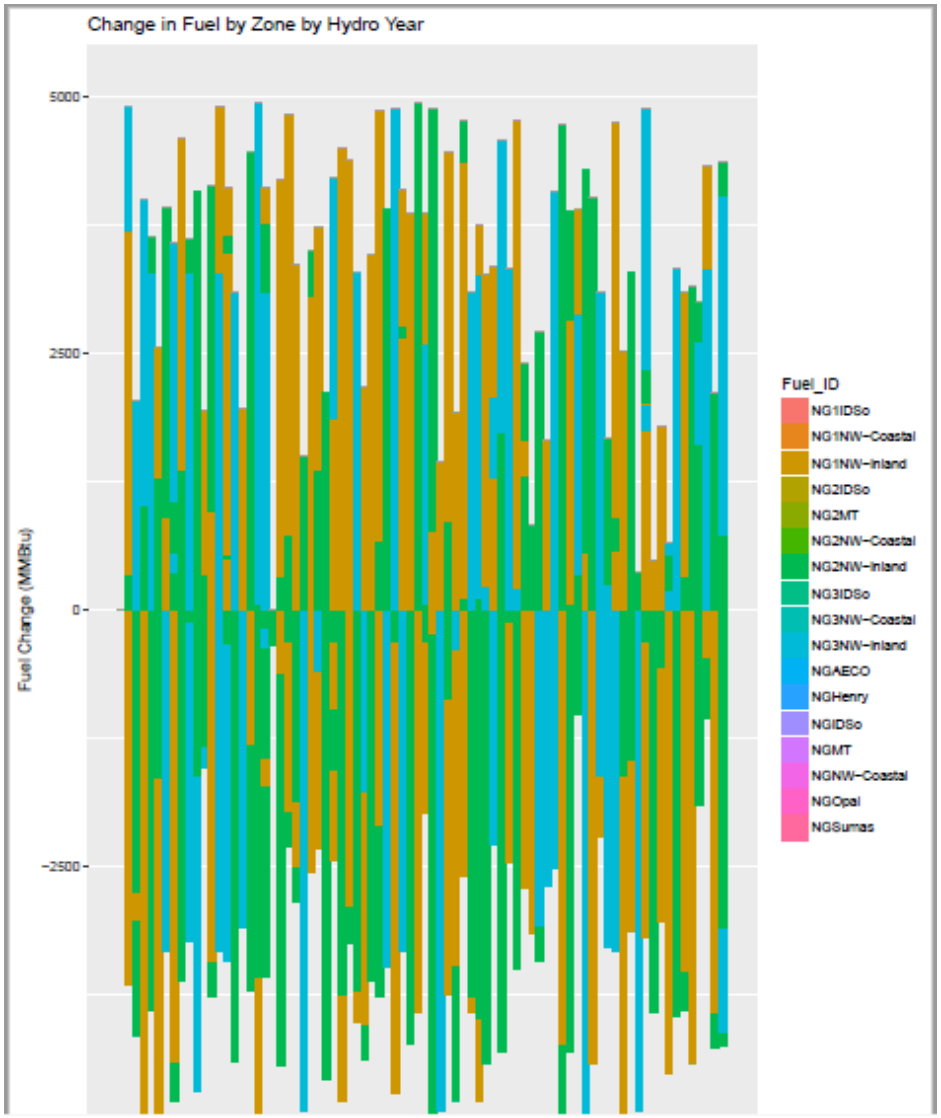
Fuel_ID

- CoalUS
- FO2
- FO2Peak
- FO2WECC
- NG1IDSo
- NG1NW-Coastal
- NG1NW-Inland
- NG2IDSo
- NG2MT
- NG2NW-Coastal
- NG2NW-Inland
- NG3IDSo
- NG3NW-Coastal
- NG3NW-Inland
- NGAECO
- NGHenry
- NGIDSo
- NGMT
- NGNW-Coastal
- NGOpal
- NGSumas
- OT
- SUN
- SUNTherm
- UR
- WAT
- WND



- Coal usage drives WECC emissions change
- Coal usage in Arizona fluctuates by month and by water condition





In the east side of the region, gas usage changes, but not often and not much.